ANALYSIS OF TRAFFIC FLOW
WITHIN A
NAVAL COMMUNICATION STATION

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THESIS

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WITHIN A
NAVAL COMMUNICATION STATION

by

Rita Heustis Bivins

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Further testing using the described computer program is recommended to provide a broader base for conclusions.

Analysis of Traffic Flow
within a
Naval Communication Station

by

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ABSTRACT

A study of the message traffic flow at a Naval Communication Station was conducted on two days to determine the percentage of traffic following certain paths within the station, and the characteristics of those paths with regard to traffic volume, precedence, time in house, peak loading periods, and length.

Incoming and outgoing messages were matched and sorted by computer. Analysis revealed that the main flow of traffic was incoming on AUTODIN and outgoing on other circuits; approximately 95% of the traffic went out on only one type of channel with little duplication within type of channel; duplication between terminations and broadcasts was minimal; and conflicting results were obtained on variation between path characteristics.

Further testing using the described computer program is recommended to provide a broader base for conclusions.

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I. INTRODUCTION

The purpose of this thesis is to examine the traffic flow within a Naval communication station to determine the percentages of traffic which moved between the various combinations of input and output channels and also to determine if these input-output combinations differed with regard to the length of the messages handled, the precedence of the traffic, the time of day at which the messages arrived, and the length of time they remained within the communication station. The Naval Electronics Laboratory Center in San Diego expressed the original interest in the subject because of their involvement with automation projects for Naval Communications. Naval Communication Station, San Francisco was chosen as the station to be studied because of its proximity and because of its possible future involvement in automation.

A. BACKGROUND

In order to provide background and understanding for this study, a brief description of the record-copy message processing capability of the Naval Communication Station, San Francisco is provided.

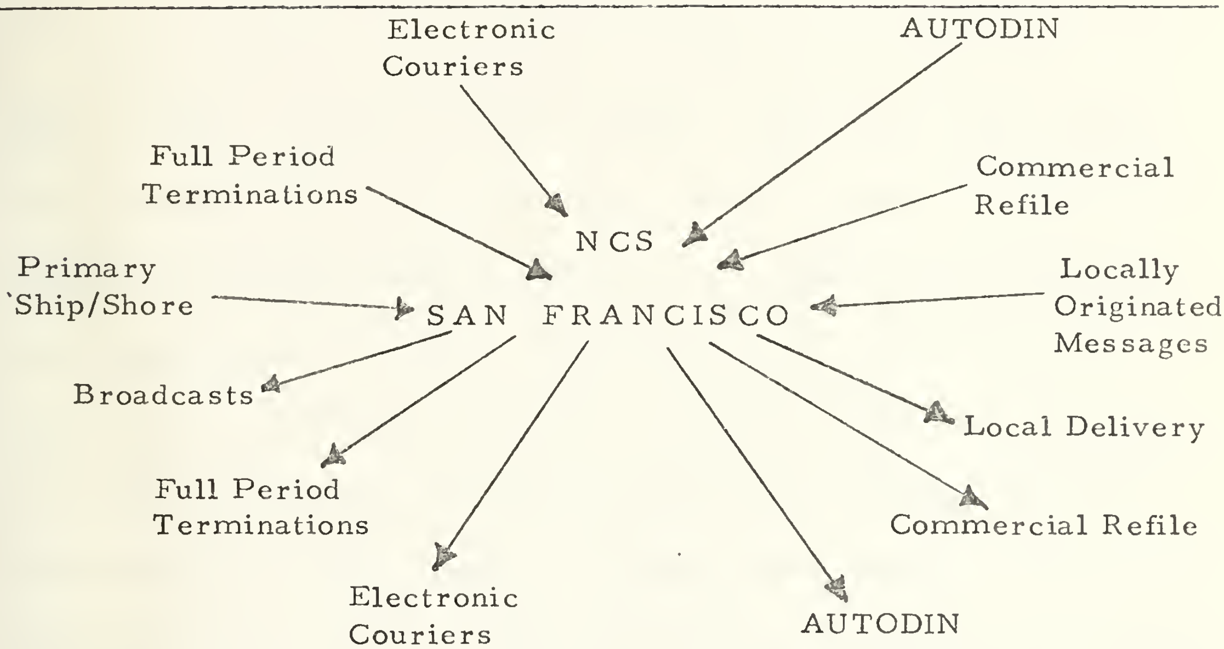
NSC San Francisco is a major communications station located at Stockton, California. It provides an interface between the ships in the Eastern Pacific area and the shore establishment. Outgoing traffic is provided by the fleet broadcast. Incoming traffic from the ships is

received on the primary ship-shore circuits. In addition, there are six full-period termination positions which with multiplexing can serve up to 18 ships on full-period dedicated circuits.

The station is an AUTODIN tributary station off the automatic switching station at McClellan Air Force Base. The AUTODIN terminal is an IBM 360-20 multi-media computer with perforated tape, page copy, and card capability. Incoming and outgoing Western Union TELEX and TWX circuits permit delivery of telegrams to and from individuals and civilian organizations. The Naval Communication Station is the Pacific Ocean Area processing point for personal telegrams for Class "E" messages to individuals aboard ship.

The station also has point-to-point "electronic courier" circuits with certain subordinate units and other land-based commands. Figure 1 summarizes the incoming and outgoing circuits of the Naval Communications Station, San Francisco.

Processing of the traffic is partially automated. The messages are received in the Communication Station as coded punched paper tape at a "receive" position. The tape is torn off manually and fed to an in-house Transmitter Distributor (TD) which transmits the message electrically to the Multiple Address Processing Unit (MAPU). This "soft-wired" reprogrammable unit reads the Format Line Two routing indicators and then delivers the message to the proper Basic Reperforator Punching Elements (BRPE) adjacent to the "send" terminal. The paper tape from



Normal Broadcast Circuits		Commands served by Electronic Couriers
FMAA----	Destroyers	NTCC Treasure Island
FMCC----	Service Forces	NAVRADSTA Jim Creek
FMEE----	Heavy Ships	NAVSECGRU Activity/NAVRADREC FAC Skaggs Island
FSPG ----	Coast Guard on-call	NAVRADTRANSFAC Dixon
FCMP----	CW Mercast	NAVHOSP Oakland
		WESTNAVFACENCOM San Bruno

Figure 1. NCS San Francisco Circuits

the BRPE is torn off manually and placed on the outgoing TD for transmission.

B. REASON FOR THE STUDY

Future concepts concerning Naval communications envision a limited number of fully-automated stations. There are at least three factors leading toward this automation. First, in order to provide money for the Fleet Satellite program, it is necessary to decrease the total number of communication stations; therefore, each remaining station must assume a greater share of the total traffic load. Second, the number of personnel in the Navy is decreasing, thereby reducing the number available for manning communications stations. Third, with the increased reliance within the Services on automated information systems and more centralized control of the operating forces, there is a need for greatly increased masses of computerized data to flow at high speeds within the communication system. Solutions to these problems will require improved automation systems with highly efficient queing, polling, and buffering schemes.

The Navy Electronics Laboratory Center (NELC) is engaged in projects which include research into such improved automated communications networks for the future. They have stated a requirement for information concerning the internal flow within communications stations in order to further such research. NELC felt that much information was available

on each individual terminal such as the number of messages, the times of arrival, their precedence, length, and so on; but that there was no quantitative information in existence on the characteristics of the paths within a communication station ("path" being defined as the combination of an incoming terminal with an outgoing terminal). Some of the questions in which NELC expressed an interest are as follows: What are the various paths that the traffic follows within the station? What is the probability that each path will be followed; for example, what is the probability that a message coming in on the AUTODIN terminal will go out on the Broadcast? Would the characteristics of the paths differ? Would there be certain paths that had a higher percent of high precedence traffic, or longer messages? Do the various paths differ with regard to peak loading time or the time between receipt and delivery? It was felt that information of this type would lead to the design of more efficient automation systems for the fully automated communication stations.

C. METHOD OF APPROACH

In order to obtain this information it was decided to take the data available concerning messages on each of the incoming channels and match it with the corresponding information available on each of the outgoing channels. This match was made by comparing the originator and date-time-group for each message. Various sampling schemes were considered. Random sampling of a certain number of messages over a

random sample of days was one method considered, which would have given a reasonable amount of validity in a statistical sense. However, the sampling procedures during the day would have had to be done by hand because of the low probability of making a match of a message and its path if a sample were made of the incoming and outgoing channels separately. The procedures would have involved taking samples from each of the incoming circuits including all of the various categories of incoming channel, precedence, time of day, length; and then tracing these messages through the Communication Station. This would have been a long, laborious task for the Traffic Analysis Section. It was determined that an exhaustive compilation of all the information on each circuit would require much less effort by station personnel, with a computer program being used to match the incoming and outgoing channels for each message. The exhaustive sample of the traffic would provide a true picture of what happened on the days sampled, but would require further samples to insure that the days sampled were representative. A two day sample was selected because of restraints on time and resources available for this project. The two day sample would provide an insight into the types of problems that might be encountered and the possible approaches for future investigations.

It was decided that one day chosen should be an average day based on the total traffic load and the number of full-period terminations in use. As a fleet exercise would be in progress within part of the time available for sampling, it was decided also to choose a day during the

exercise. It was considered that comparing the traffic patterns for these two days might provide some insight into changes that might be experienced in heavy traffic emergency operational situations. Unfortunately, the exercise was less extensive than originally planned because of the oil cut-backs by the Arabian countries.

II. DATA BASE CONFIGURATION

A. COLLECTION

The raw data was collected by the statistical section of the Communication Station from the page copies that are retained for a 30-day period, or from the message logs. Messages included in the sample were those received or transmitted between 0001 and 2400 on the fifth and fourteenth of November. The fifth was chosen because it represented an average day. There were full period terminations with the Carlisle, the Kitty Hawk, the Coral Sea, and the Chicago. The normal broadcast channels were up: FMAA for destroyers, FMCC for service forces, FMEE for heavy ships such as carriers and cruisers, FCMP for the CW Mercast providing weather information, and FSPG which is an on-call circuit with the Coast Guard. The fourteenth was chosen because it was the day during the fleet exercise, BEL BANGO, with the heaviest traffic. Full-period terminations were up with the Chicago, Horne, Juneau, Jouett, Halsey, Bainbridge, Coral Sea, Paul Revere, Monticello, and Gridley. There was also an extra broadcast channel, XRTT, up for exercise traffic. Further information on activities during the exercise are available in Ref. 3.

The data collected included the incoming (INCHAN) or outgoing (OUTCHAN) channel, the originator's routing indicator (RI), the date-time-group (DTG), precedence (PREC), time of receipt (TOR) or time

of delivery (TOD) as appropriate, and the length of the message. The length of the message was provided in line blocks as estimated by an experienced Radioman Chief. A line block as used here is 80 transmitted characters and may be made up of several physically printed lines.

B. PROGRAM

Each incoming and outgoing channel was assigned a number for the purposes of computer handling. The numbering system was different for the normal and exercise day. Figure 2 is a listing of the number assignments.

The programming was done in COBOL F in several segments because of problems which needed resolution, and which are discussed further in the section entitled "Assumptions." The programs read the raw data from punched cards (input format is contained in the File Description section of the program) and sorts the data in ascending order by RI, DTG, Channel, and TOR/TOD. This puts all of the transmissions of a message together with the incoming message first, since the incoming channel numbers are the lower numbers, and with multiple transmissions over a single channel in order of transmission. The program then creates a magnetic tape file consisting of single records (or multiple records for duplicate transmissions over the channel) for each message. Each record includes INCHAN, RI, DTG, PREC, TOR, length, TOD for each channel on which the message was transmitted, and a summary of the

CHANNEL NUMBERS

CHANNEL	Normal Day Incoming	Normal Day Outgoing	Exercise Day Incoming	Exercise Day Outgoing
AUTODIN	01	21	51	71
Ship-Shore	02		52	
Skaggs Is.		22	53	72
FMAA		23		73
FMCC		24		74
FMEE		25		75
FSPG		26		76
FCMP		27		77
XRTT				93
Hollister	03			
Coral Sea	04	33	54	83
Chicago	05	34	55	84
Kitty Hawk	06	32		
Carlisle Barracks	07	31		
Horne			56	85
Juneau			57	86
Jouett			58	87
Halsey			59	88
Bainbridge			60	89
Paul Revere			61	90
Monticello			62	91
Gridley			63	92
TI "A"	08		64	82
Jim Creek		28		78
Dixon		29		79
Western Union	30			80
TI "B"				81

Figure 2. Channel Number Assignments

major categories of outgoing channels for each message (which is later referenced as Variable 26 (VARO26)). The TOD portion of the record is divided into twenty-five columns, one for each outgoing channel. The first column is for the AUTODIN, the next 6 for the various broadcast channels, etc. A blank in a column means that channel was not used. The summary column consists of a four digit binary code in which the left-most position indicates whether the message went out on the AUTODIN, the second digit indicates transmission on a broadcast channel, the third on a full-period termination and the fourth on the other miscellaneous channels. A one indicates that the message went out on at least one of the channels in that category and a zero means that it did not. Figure 3 illustrates a record from the first file.

```
01  RUWJNA050400   PR   0410   13    0425    0424    0420......1100
 a        b     c    d      e     f                   g              h
```

a) Incoming channel number
b) Originator RI
c) DTG
d) Precedence
e) TOR
f) Length in line blocks
g) TOD on outgoing channels shown in columns 1, 3, and 5 of 25 possible columns
h) Summary data on major types of outgoing channel, indicating transmission on AUTODIN and broadcast.

Figure 3. Sample of a Record from File 1.

In addition to creating this file, the program provides a print out of messages that are not handled by the program and require manual addition

to the file. They are messages with over 11 duplicate transmissions on an incoming or outgoing channel, and Western Union or locally originated messages which have duplicate outgoing transmissions.

Some errors in the raw data were detected by inspection. Corrections were made by making individual changes to certain records in the file and by creating additional records and adding them to the file.

From this first file which had a record for each incoming transmission, a second file was created with a record for each outgoing transmission. Each record includes INCHAN, OUTCHAN, TOR, length, PREC, and TOD from File 1, plus the time between receipt and transmission called time-in-house (TINH). Figure 4 illustrates the records that would be created from the sample record in Figure 3.

01	01	0410	15	13	PR	0425
01	03	0410	14	13	PR	0424
01	05	0410	10	13	PR	0420
a	b	c	d	e	f	g

a) Incoming Channel number
b) Outgoing column number from File 1
c) TOR
d) TINH
e) Length
f) Precedence
g) TOD.

Figure 4. Sample of Records from File 2.

C. ASSUMPTIONS

Upon initial screening of the output from the initial computer programs, it was discovered that several assumptions would be necessary to complete the data base.

1. Duplicates

It was found that duplicates of individual messages, as indicated by duplicate routing indicator and date-time-group, were transmitted through the Communications Station. Some were duplicates on the incoming channels with no duplicates on the outgoing channel; some were duplicates on the outgoing channel with no incoming message; and some were duplicates on both the incoming and outgoing channels. There are several possible explanations for these occurrences.

Multi-section messages are transmitted with the same RI and DTG. Communications procedures specify that if a message has over 100 lines of text, it will be broken and transmitted in sections. Also, there were certain short card-punched messages for computer use that came through with duplicated RI and DTG.

Some messages may have been sent more than once and the duplicates noticed by the Communication Station in their screening procedures. This would account for some duplicates that came in but did not go out. Also there were messages that were transmitted at least twice on the same outgoing channel while received only once, possibly because of requests for retransmission.

In creating the computer data files for purposes of analysis, messages that came in and went out as duplicates were matched up on a first in - first out basis. There were a few situations in which this procedure was modified because the TOR/TOD's indicated against it. Those duplicates that were sent out but had no incoming match were assigned a dummy incoming channel number of 17 on the normal day and 67 on the exercise day. These duplicates which came in but had no outgoing match were assigned a dummy outgoing channel number of 99 in File 2.

2. Non-matching messages

Another situation which required resolution was the large percentage of the traffic which did not match up. It appeared that traffic was leaving without coming in or vice-versa. There are several explanations for this. A small percent of the official traffic does originate or terminate at the station and therefore would have no apparent incoming or outgoing channel, as the case may be.

Another category of message that originates and terminates at the Communication Station is the service message. This is a communicator's informal tool to request clarification of errors, to request duplicate transmission, or other procedural information.

Telegrams are also received in and transmitted from the station. These telegrams can arrive by two methods: by commercial teletype or by telephone. From both these sources the messages are

organized into the proper format for Navy communication channels by the Communication Station and assigned an originating routing indicator and DTG, making it appear that they originated at the Communication Station. Data was provided on the normal day for the "telephoned" messages which were assigned an incoming channel number of 30. On the exercise day, data was provided only from the outgoing commercial teletype lines.

Another explanation for the non-match is that because of the method of data collection, messages overlapped with the previous or following day's messages. Messages that came in before the sample day but were transmitted on the sample day would show up as outgoing with no incoming match. At the end of the day, the reverse would be true; messages would be received that would be retransmitted on the following day.

Messages that originated at the Communication Station could be identified by the originator's routing indicator and were assigned a dummy incoming channel number of 19 on the normal day and 69 on the exercise day with the exception of the previously mentioned normal day's telegrams. Messages which had no apparent incoming channel but which did not have an originator's RI, were assigned a dummy channel number of 18 or 68. Messages that apparently terminated in the Communication Station appeared in File 1 as having no outgoing channels and were assigned dummy channel number of 99 in File 2.

To summarize the channel numbers assigned because of assumptions, dummy incoming numbers of 17 and 67 indicate outgoing duplicates

with no apparent incoming channel; channel numbers of 18 and 68 indicate no apparent incoming channel; and channel numbers of 19 and 69 indicate messages originated within the Communication Station. All messages that appeared to terminate at the Station were assigned an outgoing channel number of 99 in File 2.

3. Precedence and Time-in-House

Some messages are assigned dual precedence, a higher precedence for the action addressee than for the information addressee. As it could not be determined which of the outgoing channels was the one receiving the action traffic and which had the information traffic, only the higher precedence was used in precedence analysis.

The amount of time recorded that a message spends in the Communications Station is a function of not only the actual time but also the accuracy of the clocks and time stamps used to document the time of receipt and time of delivery. For this reason there is a small percentage of traffic which appears to have a negative time-in-house. Also because of the method of time stamping, the time of delivery is not totally accurate except on the AUTODIN circuit. On the AUTODIN circuit the IBM 360-20 automatically prints the TOD on the file copy. However, in the other circuits the messages are likely to be bulk-processed; that is, they are time-stamped in groups after they have been transmitted, rather than singly as they are transmitted. It was interesting to note that even with these limitations, over 90% of the

traffic for which there was data had been transmitted within 30 minutes after receipt.

III. ANALYSIS PROCEDURES

The data base was analyzed by computer using the Statistical Package for the Social Sciences (SPSS) [Ref. 2]. The SPSS combines many of the commonly used statistical techniques in a single program package. This package contains one-way frequency distributions and related statistics, table displays of relationships between two or more variables and related statistics, bivariate correlation analysis, partial correlation, multiple-regression analysis, scalogram analysis, and factor analysis.

Since one of the primary questions of the thesis is "What is the probability that a message coming in on channel X will go out on channel Y? ", the cross-tabulation subroutine of SPSS which provides table displays of relationships between two or more variables was the one chosen. The computer printouts displaying the relationships between the incoming channel (INCHAN) and the summary data (VARO26) on the types of outgoing channel, and between INCHAN and the outgoing channel (OUTCHAN) are given in Appendices A and B.

In performing cross tabulations, the computer takes two variables and forms a matrix using the number of cases in each cell. Information is printed out by the computer on the number of cases that occurred in that cell, the percentage of the row total that number of cases constitutes, the percentage of the column total, and the percentage of the total number of cases used in the matrix. Using the second cell in the first horizontal

row of the cross tabulation in Appendix B as an example, 232 messages came in on the AUTODIN channel and went out on at least one broadcast channel. The 232 messages constituted 23% of all the traffic that came in on the AUTODIN channel, and 98.7% of the traffic that went out on the broadcast channels. It accounted for 18.2% of the total traffic during the day. The figures to the extreme right are the Row totals and the percent of the total traffic included in that row. The figures at the bottom of the chart represent the column totals and the column percentages. In the previously mentioned example 79.1% of the traffic came in over the AUTODIN circuit and 18.4% of the total traffic went out over at least one broadcast channel. The channels that have ship names are full-period terminations with that ship.

The second question was "Do these various paths differ with regard to peak loading time, time between receipt and delivery, precedence of the traffic and length of the messages?" Various statistical methods were considered for analysis of these variables, including correlation analysis and factor analysis. Correlation analysis provides a "single summary statistic describing the strength of association between two variables" [Ref. 2]. The correlation procedures in SPSS investigate the linear correlation among variables which are at least ordinal in scale. Since there was no reason to believe that the relationship between the path and the time in house, for example, was linear and especially since the path was not ordinal in nature, this family of procedures was

not used. Factor analysis allows one "to see whether some underlying pattern of relationships exist such that the data may be 'rearranged' or 'reduced' to a smaller set of factors or components that may be taken as source variables accounting for the observed interrelations in the data" [Ref. 2]. Factor analysis is based on correlation analysis and so the same objections held as discussed previously. Certain relationships among the data could have been analyzed using these methods; for example, the relationships among time in house, length, time of receipt and precedence. However, since these relationships were not primary objectives of this paper and because of time limitations this direction was not pursued. It was decided to do two-way cross tabulations of the various characteristics and these were done on the following combinations: Path by TOR, TINH, PREC and length; INCHAN by TOR, PREC, and length; and OUTCHAN by TOD.

Each cell of the cross tabulations in Appendix B represents a path within the Communications Station. On the normal day, there were 26 cells or paths containing entries so all paths were used for analyzing TOR, TINH, PREC, and length. On the exercise day, because of the large number of cells with entries, 70, it was decided to group the cells with fewer entries in order to keep the number of combinations to a manageable limit. Those cells with 10 or less entries were combined, and constitute 8.4% of the total traffic on the exercise day. There were 26 individual paths analyzed, leaving 44 paths grouped as "ten or

less". Figure 7, in the results section, lists the paths analyzed and percent of traffic associated with each.

Because of the voluminous amount of paper involved, these print-outs have not been included in this thesis but have been forwarded to NELC.

In order to bring these cross tabulations into some sort of easily understood format, graphs of the characteristics were made on total traffic on the paths with the larger number of messages involved. The graphs to be included here were chosen with three basic criteria in mind: large traffic volume, even distribution between exercise and normal day traffic, and balance between types of channels (AUTODIN incoming and outgoing, broadcast, dedicated channels, and ashore channels). Figure 9 in the results section includes ten individual graphs showing the percentage of traffic received each hour for total traffic and the following nine paths: AUTODIN-Skaggs Island, AUTODIN-FMCC, AUTODIN-FCMP, AUTODIN-Coral Sea, Shipshore-AUTODIN, AUTODIN-Kitty Hawk, Coral Sea-AUTODIN, AUTODIN-Juneau, and Horne-AUTODIN. Figures 10 through 12 show percentage patterns for TINH, PREC and length on the same paths just listed.

It should be noted that as the number of messages per path decreases, a small actual-number variation causes large variation in percentage and apparently erratic behavior.

D. CHI-SQUARE ANALYSIS

Although the visual representations present a simple way of looking at the material and one can arrive at his own judgement as to whether or not the patterns are "the same" or "different", it was felt that statistical analysis would give a more objective determination as to whether the observed differences were significant. The Chi-square test was used [Ref. 1].

One application of the Chi-square test is to explore the independence of the two set of observed events. An example would be the testing of TOR's to determine whether their pattern varied between the normal and exercise days. If they are independent (i. e., not affected by the day), then the patterns will appear similar. If they are independent, an expected cell probability would be approximately equal to the product of its respective row and column probabilities. The data in Appendix A is used as an example to explain how the Chi-square is computed (although the test was not actually applied to this cross-tabulation for reasons explained below). In the example, in order to get the expected value of the cell in row 1, column 3, the row total, 1008, is multiplied by the column total, 213, and then divided by the cross-tabulation total, 1274. The expected value for the cell would therefore be 168. The Chi-square figure is computed by summing up for all cells the squared difference between each observed cell value and its expected value divided by the expected value,

$$\frac{(\text{Observed value minus Expected value})^2}{\text{Expected Value}} .$$

The null hypothesis that the observations are independent is tested by comparing the computed Chi-square with the appropriate statistical table to indicate whether the differences exceed those expected by chance.

In order to apply the Chi-square test a rule of thumb requires that each expected cell count equal or exceed five. Because of the large number of vacant cells, the total cross tabulations could not be analyzed in this manner; however, the method could be used on totals between the exercise and normal days and was so used.

IV. RESULTS

The discussion of results is divided into four sections: a general overview of the results; a look at the cross tabulations for INCHAN versus the summary date (VARO26) in Appendix A, and INCHAN versus OUTCHAN in Appendix B; a look at the charts summarizing the paths versus the various characteristics; and the Chi-square analysis of some of the totals of the two day's traffic.

A. GENERAL OVERVIEW

For a broad overview of what the statistics provided, the table in Fig. 5 was compiled using the row and column totals of Appendices A and B. The totals were combined into four broad categories of AUTODIN, broadcast, dedicated circuits, and miscellaneous circuits. Their contributions to both the incoming (from Appendix A) and outgoing (from Appendix B) message totals are displayed in Figure 5. As can be seen, the general flow of the traffic is into the Fleet Center via the AUTODIN and out on the other circuits.

B. CROSS TABULATIONS

From Appendix A, it is apparent that only a small percentage of the traffic goes out on a combination of types of channels; that is on the AUTODIN and also on the broadcast, and so on. By adding the percentages involved, it was discovered that 97.8 percent of the incoming

	PERCENT OF INCOMING TRAFFIC		PERCENT OF OUTGOING TRAFFIC	
	NORMAL	EXERCISE	NORMAL	EXERCISE
AUTODIN	79.1	75.2	17.9	18.4
SHIPSHORE or BROADCAST	4.5	4.2	27.0	38.6
DEDICATED	11.3	14.9	16.3	18.3
MISC.	5.1	5.7	38.7	24.8

Figure 5. Incoming and Outgoing Traffic by Broad Category

messages on a normal day, and 93.6 percent on the exercise day went out on only one type of channel.

Since the summary data from Appendix A provides information on the number of messages that went out on at least one of the general categories of channel, a natural question arising from this data is what percentage of the traffic that goes out on one of the channels also goes out on another channel of the same type. This information was obtained by a by-product of the program which initially sorted the raw data, and the results are provided in Figure 6. Only a small percentage of the traffic goes out on two or more channels of the same type, with the exceptions of the broadcast channels where approximately 21% of the traffic was duplicated.

The first question raised in the creation of this project was "What is the probability that a message coming in on Channel X will go out on Channel Y?" The answer for the two days involved is provided in Appendices A and B. The information is summarized in Figure 7.

		Number of Outgoing Channels Within a Category				
		1	2	3	4	5
Broadcast	NORM	77.1	3.4	12.8	6.4	0.3
	EXER	81.9	5.8	7.6	4.8	0.7
Dedicated Circuits	NORM	99.2	0.8			
	EXER	92.1	6.5	0.8	0.3	0.3
Misc. Circuits	NORM	98.6	1.4			
	EXER	95.9	3.0	1.1		

Figure 6. Multiple Transmissions Within Categories

PATHS		NORMAL NO.	NORMAL PER CENT	EXERCISE NO.	EXERCISE PER CENT
AUTODIN	Skaggs Is.	549	37.7	265	14.4
AUTODIN	FMCC	155	10.6	234	12.7
AUTODIN	Kitty Hawk	124	8.5		
AUTODIN	FMAA	122	8.4	189	10.2
AUTODIN	Coral Sea	85	5.8	100	5.4
AUTODIN	FMEE	79	5.4	153	8.3
AUTODIN	W. Union			138	7.5
Skaggs Is.	AUTODIN			81	4.4
Coral Sea	AUTODIN	63	4.3		
W. Union	AUTODIN	61	4.2		
AUTODIN	Juneau			69	3.7
Ship Shore	AUTODIN	55	3.8	60	3.3
Carlisle	AUTODIN	44	3.0		
Horne	AUTODIN			49	2.7
Juneau	AUTODIN			48	2.6
Kitty Hawk	AUTODIN	20	1.4		
AUTODIN	Horne			45	2.4
AUTODIN	FSPG	19	1.3	36	2.0
AUTODIN	FCMP	15	1.0	29	1.6
Jouett	AUTODIN			33	1.8
Carlisle	Carlisle	13	0.9		
AUTODIN	Dixon	13	0.9	15	0.8
Hollister	AUTODIN	10	0.7		
AUTODIN	Chicago	7	0.5	20	1.1
AUTODIN	Jouett			17	0.9
Halsey	AUTODIN			16	0.9
Horne	XRTT			16	0.9
AUTODIN	Gridley			15	0.8
AUTODIN	Paul Revere			14	0.8
AUTODIN	TI"A"			14	0.8
AUTODIN	TI"B"			12	0.7
AUTODIN	XRTT			11	0.6
AUTODIN	Halsey			11	0.6
Chicago	AUTODIN	6	0.4		
AUTODIN	Carlisle	3	0.2		
Ship Shore	FMCC	3	0.2		
W. Union	Coral Sea	3	0.2		
AUTODIN	AUTODIN	2	0.1		
AUTODIN	Jim Creek	2	0.1		
Coral Sea	Kitty Hawk	1	0.1		
W. Union	FMAA	1	0.1		
W. Union	Kitty Hawk	1	0.1		
Ten or less transmissions (EXERCISE)				155	8.4

Figure 7. Tabulation of Paths and Loads

Another grouping of the information that is of particular interest shows the amount of traffic that goes out on both the dedicated and the broadcast circuits. One of the purposes of bringing a ship up on a full-period termination is to keep the broadcast circuits from being over-loaded. It can be seen from the combinations in Appendix A containing both "B" and "D", that few messages are in fact transmitted over that combination and so the dedicated circuits are cutting down on the broad-cast loading problems. On the normal day 249 messages were trans-mitted over the broadcast channels (singly or in combination), 235 were transmitted over the dedicated channels and only 5, or 2% of the broad-cast traffic, were transmitted over both the broadcast and dedicated channels. On the exercise day, 478 messages were transmitted over the broadcast channels, 247 went out on the dedicated channels, while 42 or 8.8% of the broadcast traffic went out on a combination of the broadcast and dedicated channels.

It is also interesting to note that only a very small percentage of the traffic -- .6% on the normal day and 2.1% on the exercise day -- passed through the Fleet Center without in some way involving the AUTODIN circuit, either incoming or outgoing, singly or in combina-tion with one of the other types of circuits.

The cells from Appendix A are listed below in Figure 8 in order of the amount of traffic they contain. Those cells with less than 10 mes-sages are not included. They make up 2.6% of the traffic on the normal day and 9.7% on the exercise day.

INCHAN	SUMMARY (VARO26)	% OF TOTAL TRAFFIC NORMAL	EXERCISE
AUTODIN	Miscellaneous	43.1	28.8
AUTODIN	Broadcast	18.2	26.3
AUTODIN	Dedicated	16.6	16.6
SKAGGS ISLAND	AUTODIN		5.6
CORAL SEA	AUTODIN	4.9	
WESTERN UNION	AUTODIN	4.7	
SHIP SHORE	AUTODIN	4.2	4.0
JUNEAU	AUTODIN		2.6
CARLISLE	AUTODIN	2.5	
HORNE	AUTODIN		2.5
AUTODIN	Broadcast-Dedicated		2.1
KITTY HAWK	AUTODIN	1.6	
JOUETT	AUTODIN		1.4
HALSEY	AUTODIN		1.0
CARLISLE	AUTODIN-Dedicated	0.9	
HOLLISTER	AUTODIN	0.8	

Figure 8. Summary of Major Traffic Distribution

The second set of Cross Tabulations -- INCHAN by OUTCHAN -- are presented in Appendix B. The patterns are very similar to those shown in the INCHAN by VARO26, as would be expected. There are two items that require further explanation. Two messages on the normal day and six on the exercise day came in on the AUTODIN channel and went out on the AUTODIN channel. This may have been caused by messages that were misrouted to the station and, when discovered, were corrected and re-entered into the AUTODIN system. The thirteen messages that were received from and sent out to the Carlisle on the normal day were part of a communications test with that ship.

C. PATHS VERSUS VARIOUS CHARACTERISTICS

Looking at the four charts of the totals in Figures 9 through 12, the daily patterns are similar for length, TINH and precedence. The TOR patterns are more subtle; however, there is a general tendency toward a bi-modal pattern with the heavier traffic late at night and early in the morning.

1. Time of Receipt

The patterns for TOR, Figure 9, show wide variations between the days on the individual paths, even though the patterns for the totals appear similar. Also, the variation between days on the same path appears as great as the variation between paths.

2. Time in House

For TINH, the visual representations in Figure 10 clearly show a very similar handling of the total traffic on the two days. The most noticeable difference occurred in the AUTODIN-FCMP path, with modal point being 1-3 hours, vice the 0-15 minutes for the other paths. This is caused quite logically because the FCMP broadcast is transmitted at scheduled intervals, and the incoming traffic must await those intervals. The paths that include the AUTODIN as the outgoing channel show a different pattern indicating a faster handling time if the traffic is flowing toward the AUTODIN terminal than if it flows away. This could be caused by the method of bulk processing the TOD stamp on the outgoing broadcast copies vice the automatic stamping of the TOD

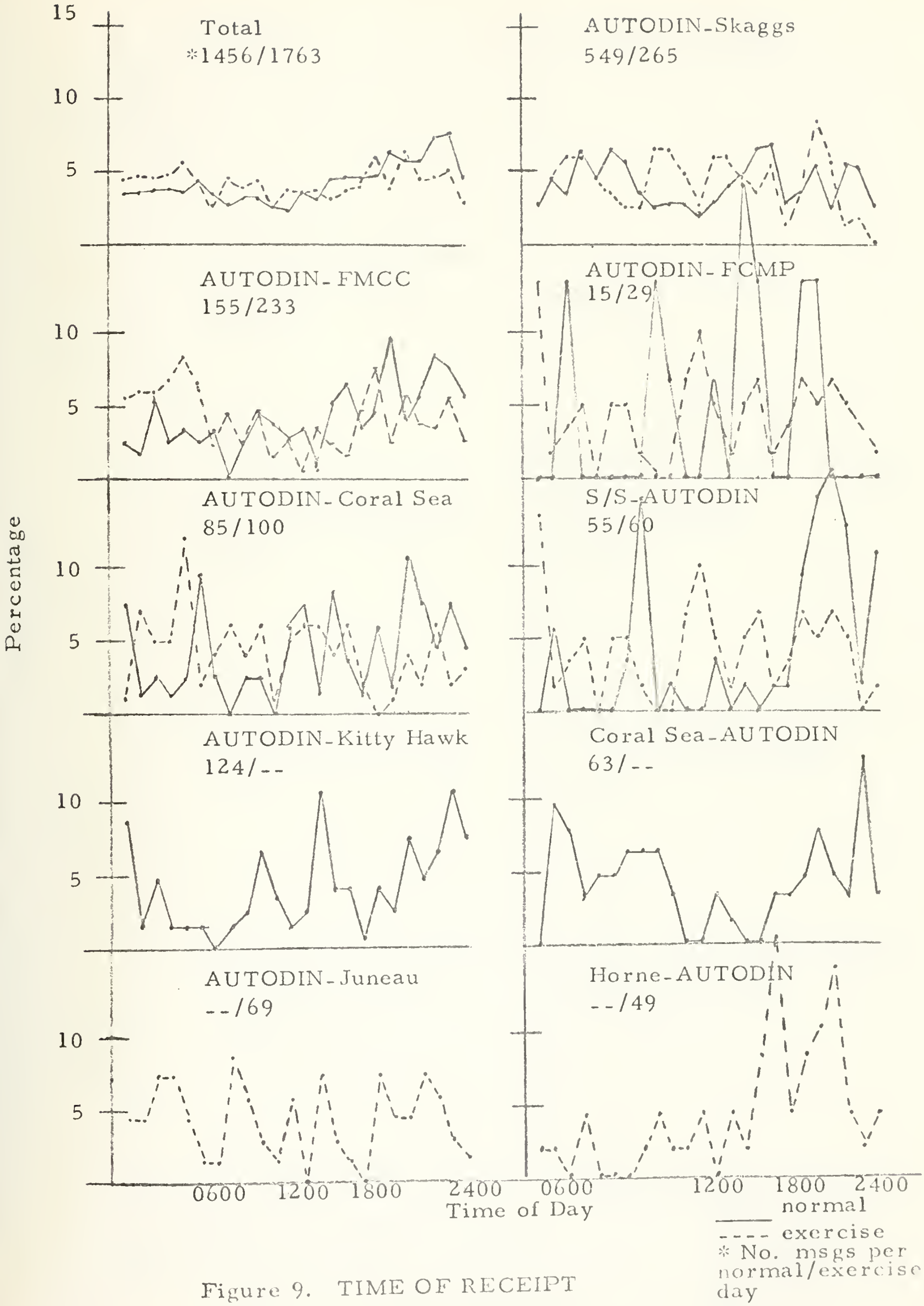


Figure 9. TIME OF RECEIPT

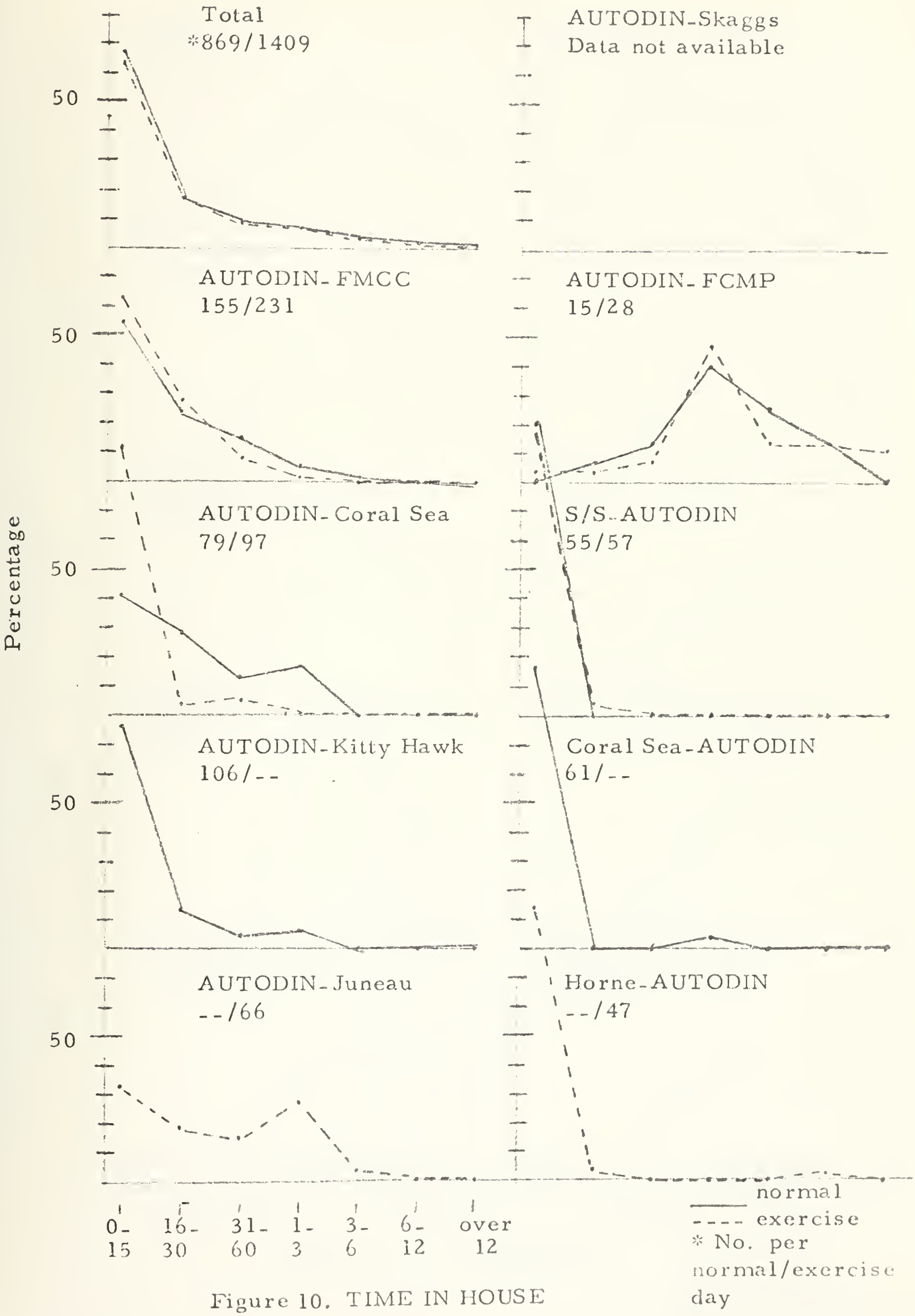


Figure 10. TIME IN HOUSE

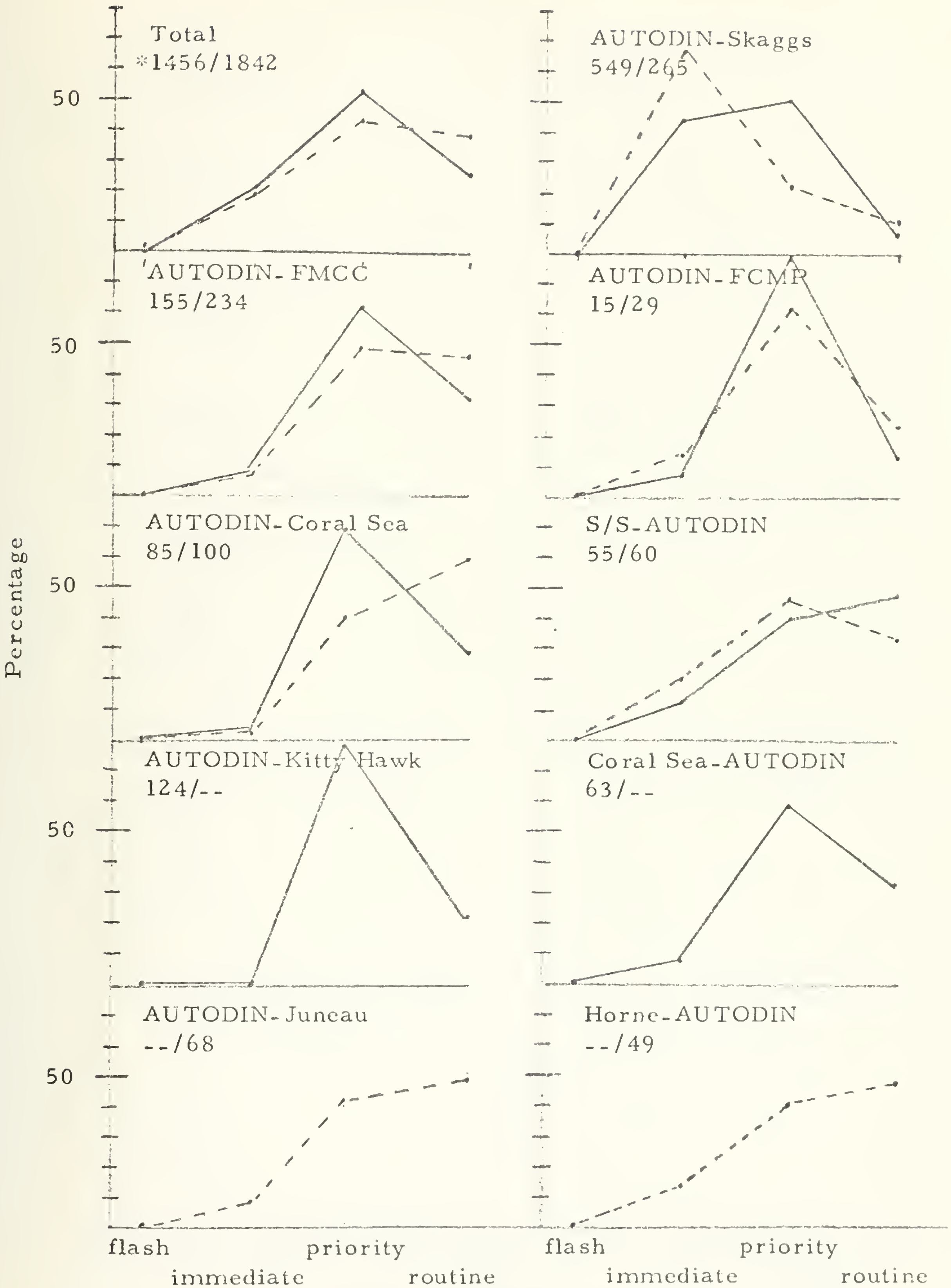


Figure 11. PRECEDENCE

____normal
----exercise
* No. msgs per normal/exercise day

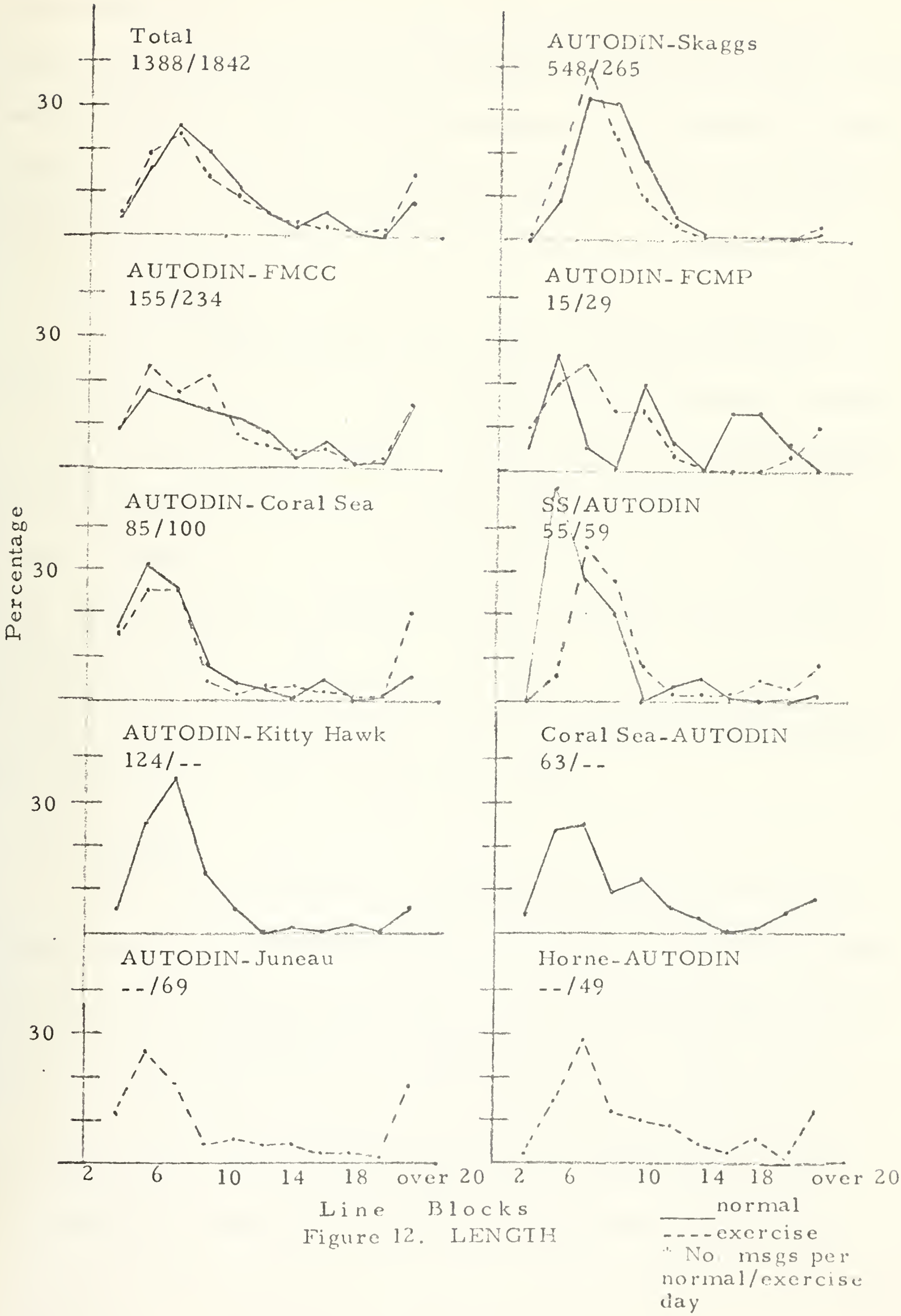


Figure 12. LENGTH

on the AUTODIN circuit; by the slower transmission speeds from the 100 word per minute teletypes vice the 1500 word per minute IBM-360-20; or by the smaller amount of traffic flowing toward the AUTODIN terminal allowing for less delay due to handling. There is some visual evidence for believing that variation between paths exists.

3. Precedence

In the graphs of precedence, Figure 11, there is a general pattern which shows a low number of Flash messages received, a slight increase in Immediate messages, a steep increase in Priority messages, and then a slight decrease in the number of Routine messages. The balance between routine and priority messages is closer on the exercise day, whereas it would be assumed that there would be greater amounts of higher precedence traffic on the exercise day. The AUTODIN-Skaggs circuit with its higher percentage of Immediate messages shows the only major alteration to the general pattern.

4. Length

The original computer runs on path by length were made with length ranging from zero to two hundred line blocks and grouped by each ten line blocks as shown in Figure 12. Visual inspection of the numbers in the cells indicated that they would all follow the same general pattern with 80 - 100% of the messages in the cells being between one and ten line blocks long. It was decided to regroup the messages by each two line blocks up to twenty and to group all those greater than twenty into

one category. The over-twenty group comprised only 10.2% of the total traffic. Six to eight line blocks seem to be the most "popular" sizes. The variation between the paths appears to be greater than the variation between days for each path.

D. CHI-SQUARE ANALYSIS

The Chi-square tests were used to give an objective basis for determining if the observed patterns were significantly different.

An informal survey of opinions on which of the four graphs for total traffic, Figures 9 through 12, indicate the "most similarity between days," resulted in agreement that TINH patterns were the most similar and TOR the most dissimilar. There was disagreement on ranking PREC and length.

However, when Chi-square tests were run on the total traffic, the null hypothesis was rejected at the .005 level of confidence only for precedence and length. The differences for TOR and TINH could be expected by chance. The summary of the tests is contained in Figure 13.

This would indicate that the pattern for TINH and TOR is general and might be expected to appear every day whereas it is probable that precedence and length are affected by days sampled and could be expected to vary.

The visual observation and statistical analysis disagree, especially with regard to TOR which visual observation would indicate to have dissimilar patterns whereas the Chi-square test indicates similar patterns at the .005 level of confidence.

CHARACTERISTIC	MINIMUM CHI SQ. TO REJECT NULL HYPOTHESIS AT .005 LEVEL	ACTUAL CHI SQ.	REJECT
TINH	18.56	8.18	NO
TOR	44.18	39.24	NO*
PREC	12.84	54.81	YES
LENGTH	25.19	113.53	YES

*Null hypothesis could be rejected at .025 level which requires a minimum Chi-square of 38.08.

Figure 13. Summary of Chi-square Analysis of Total Traffic Between Days

Visual inspection of the various charts within each characteristic grouping would appear to show that there is greater variation between the days on individual paths than on the total traffic. Chi-square tests were run on paths that allowed use of this test (because of the requirement of having an expected value of at least five in each category). Analysis was done on the AUTODIN-Skaggs Island path for the TOR; and the AUTODIN-Skaggs, AUTODIN-FMCC, AUTODIN-Corsl Sea, and Ship Shore-AUTODIN paths for precedence. Figure 14 presents the results.

Again it was discovered that visual inspection and statistical analysis do not necessarily agree. Using the precedence graphs, Figure 11, the variation for the total messages was sufficient to reject the null hypothesis. Two of the paths, AUTODIN-FMCC and Ship Shore-AUTODIN, which appear to be more widely varying, however, do not

have sufficient statistical variation to indicate that the day sampled affects the precedence distribution.

DATA ANALYZED	MINIMUM CHI SQ. TO REJECT NULL HYPOTHESIS at .005 level	ACTUAL	REJECT
TOR/AUTO-SKAGGS IS./ BETWEEN DAYS	44.18	66.56	YES
PREC/BETWEEN DAYS/ AUTO-SKAGGS	10.60	57.77	YES
AUTO-FMCC/	10.60	7.63	NO
AUTO-CORAL SEA/	10.60	16.30	YES
SS-AUTODIN/	10.60	3.32	NO
PREC/NORMAL DAY/ BETWEEN ABOVE PATHS	18.55	164.83	YES
PREC/EXERCISE DAY/ BETWEEN ABOVE PATHS	18.55	286.70	YES

Figure 14. Summary of Chi-square Analysis of Various Paths Between Days

The difference between the Chi-square results and visual observation in comparing total traffic patterns with individual paths may be caused by small variations appearing more extreme when a small number of cases is plotted as percentages. Consequently, the smaller the number of cases being plotted, the larger the visual variation will have to be in order to be statistically significant.

V. SUMMARY/CONCLUSIONS

This thesis was undertaken to provide understanding of the traffic flow within the NCS Stockton from the incoming circuits to the outgoing circuits, to determine the percentage of traffic that flowed over the various paths (a combination of an incoming and outgoing channel) within the Station, and to determine if these paths differed with respect to the characteristics of time of receipt, time in house, precedence or length.

A computer program was developed which takes two days of traffic (a normal day and an exercise day) and combines the data from incoming and outgoing messages to form records of the path/paths used by each message. These records were analyzed using a packaged computer program for statistical analysis.

It was found that the main flow of traffic is from the incoming AUTODIN to the other outgoing circuits. Approximately 95% of the traffic on the two days went out on only one type of channel (AUTODIN, broadcast, dedicated terminations or miscellaneous) and that, except for the broadcast channels which had approximately 21% duplication, there was little duplication within type of channel. Duplication between dedicated termination and broadcast channels amounted to 2% and 8.8% of the traffic on the broadcast channels.

The percentage of traffic that passed over each of the paths was segregated by the computer program and presented in matrix form in Appendices A and B.

The traffic characteristics (TOR, time in house, precedence and length) for total daily traffic showed similarities between days when viewed graphically. Statistical tests, however, indicated that the variations for precedence and length were greater than would be expected by chance, indicating that these characteristics do not have a pattern that is consistent from day to day. Proportionately more low precedence traffic was sent on the exercise day than on the normal day, which is not what would be expected by intuition.

Concerning the question of variations between paths, the graphs showed that on the two days involved, the variation in TOR between days for each path was as great as the variation between paths on a single day. For TINH, visual evidence exists that there was a consistent variation between paths. Indications for precedence are that there is little variation between paths except for the AUTODIN-Skaggs Island path. The variation in length between paths appears to be greater than the variation between days for each path.

Due to the conflict between the evidence presented by the graphs and statistics, further research is recommended covering several days over a wider period of time. This would provide a wider base for conclusions and could be accomplished with careful assignment of channel numbers and minor modification to the computer programs created for this research.

APPENDIX A

Cross Tabulation of INCHAN by Summary Data

CRCSSTABS FOR NORMAL DAY 03/19/74 PAGE 3

FILE NCNAME (CREATION DATE = 03/19/74)
SUBFILE NORMAL

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
INCHAN BY VARC26
* PAGE 1 OF 2

INCHAN	VARC26	COUNT / ROW PCT / COL PCT / TOT PCT	A 0	B 1	D 2	M 3	AB 4	AC 5	BC 7	BM 8	ROW TOTAL
AUTODIN	1	COUNT	2	232	212	549	0	0	5	8	1008
		ROW PCT	0.2	23.0	21.0	54.5	0.0	0.0	0.5	0.8	79.1
		COL PCT	0.8	98.7	98.1	100.0	0.0	0.0	100.0	100.0	
		TOT PCT	0.2	18.2	16.6	43.1	0.0	0.0	0.4	0.6	
SHIP SHORE	2	COUNT	54	2	0	0	1	0	0	0	57
		ROW PCT	94.7	3.5	0.0	0.0	1.8	0.0	0.0	0.0	4.5
		COL PCT	22.0	0.9	0.0	0.0	100.0	0.0	0.0	0.0	
		TOT PCT	4.2	0.2	0.0	0.0	0.1	0.0	0.0	0.0	
HOLLISTER	3	COUNT	10	0	0	0	0	0	0	0	10
		ROW PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
		COL PCT	4.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CORAL SEA	4	COUNT	62	0	0	0	0	1	0	0	63
		ROW PCT	98.4	0.0	0.0	0.0	0.0	1.6	0.0	0.0	4.9
		COL PCT	25.2	0.0	0.0	0.0	0.0	7.1	0.0	0.0	
		TOT PCT	4.9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	
CHICAGO	5	COUNT	6	0	0	0	0	0	0	0	6
		ROW PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
		COL PCT	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
KITTY HAWK	6	COUNT	20	0	0	0	0	0	0	0	20
		ROW PCT	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
		COL PCT	8.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		TOT PCT	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CARLISLE	7	COUNT	32	0	1	0	0	12	0	0	45
		ROW PCT	71.1	0.0	2.2	0.0	0.0	26.7	0.0	0.0	3.5
		COL PCT	13.0	0.0	0.5	0.0	0.0	85.7	0.0	0.0	
		TOT PCT	2.5	0.0	0.1	0.0	0.0	0.9	0.0	0.0	
INCHAN	30	COUNT	60	1	3	0	0	1	0	0	65
		ROW PCT	92.3	1.5	4.6	0.0	0.0	1.5	0.0	0.0	5.1
		COL PCT	24.4	0.4	1.4	0.0	0.0	7.1	0.0	0.0	
		TOT PCT	4.7	0.1	0.2	0.0	0.0	0.1	0.0	0.0	
COLUMN TOTAL			246	235	216	549	1	14	5	8	1274
			19.3	18.4	17.0	43.1	0.1	1.1	0.4	0.6	100.0

CROSSTABS FOR EXERCISE CAY 03/19/74 PAGE 3

FILE NONAME (CREATION DATE = 03/19/74)
SUBFILE EXERCISE

* C R O S S T A B U L A T I O N O F *
INCHAN BY VARC26
* PAGE 1 OF 4

INCHAN	COUNT ROW PCT COL PCT TOT PCT	A 0	B 1	D 2	M 3	AB 4	AC 5	AM 6	BD 7	BM 8	ABD 10	ABM 11	BDM 13	ROW TOTAL
AUTOCIN	51	2 0.2 0.7 0.1	381 35.0 95.5 26.3	240 22.0 97.2 16.6	418 38.4 99.5 28.8	3 0.3 11.5 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	31 2.8 100.0 2.1	9 0.8 100.0 0.6	1 0.1 14.3 0.1	0 0.0 0.0 0.0	4 0.4 100.0 0.3	1089 75.2
SHIPSHORE	52	58 95.1 19.9 4.0	0 0.0 0.0 0.0	1 1.6 0.4 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.6 8.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.6 14.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	61 4.2
SKAGGS IS	53	81 100.0 27.8 5.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	81 5.6
CORAL SEA	54	7 100.0 2.4 0.5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 0.5
CHICAGO	55	9 81.8 3.1 0.6	0 0.0 0.0 0.0	1 9.1 0.4 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 9.1 8.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	11 0.8
HORNE	56	36 62.1 12.4 2.5	8 13.8 2.0 0.6	1 1.7 0.4 0.1	0 0.0 0.0 0.0	5 8.6 19.2 0.3	4 6.9 33.3 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 5.2 42.9 0.2	1 1.7 50.0 0.1	0 0.0 0.0 0.0	58 4.0
JANEAU	57	38 71.7 13.1 2.6	3 5.7 0.8 0.2	1 1.9 0.4 0.1	1 1.9 0.2 0.1	7 13.2 26.9 0.5	1 1.9 8.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.9 14.3 0.1	1 1.9 50.0 0.1	0 0.0 0.0 0.0	53 3.7
	COLUMN TOTAL	291 20.1	399 27.5	247 17.0	420 29.0	26 1.8	12 0.8	1 0.1	31 2.1	9 0.6	7 0.5	2 0.1	4 0.3	1449 100.0

(CONTINUED)

CROSSTABS FOR EXERCISE DAY 03/19/74 PAGE

FILE NONAME (CREATION DATE = 03/19/74)
SUBFILE EXERCISE

* C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
INCHAN BY VAR026
* PAGE 3 OF 4

INCHAN	COUNT / ROW PCT / COL PCT / TOT PCT	VAR026 A 0	B 1	D 2	M 3	AB 4	AC 5	AM 6	BC 7	BM 8	ABC 10	ABM 11	BCM 13	ROW TOTAL
JOUETT	58	21 55.3 7.2 1.4	3 7.9 0.8 0.2	2 5.3 0.8 0.1	0 0.0 0.0 0.0	8 21.1 30.8 0.6	4 10.5 33.3 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	38 2.6
HALSEY	59	14 87.5 4.8 1.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 6.3 8.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 6.3 14.3 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	16 1.1
BAINBRIDGE	60	4 30.8 1.4 0.3	4 30.8 1.0 0.3	1 7.7 0.4 0.1	0 0.0 0.0 0.0	3 23.1 11.5 0.2	0 0.0 0.0 0.0	1 7.7 100.0 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	13 0.9
PAUL REVERE	61	9 100.0 3.1 0.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	9 0.6
MONTECELLO	62	8 100.0 2.7 0.6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	8 0.6
GRIDLEY	63	4 100.0 1.4 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 0.3
TI 'A'	64	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 100.0 0.2 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.1
	COLUMN TOTAL	291 20.1	399 27.5	247 17.0	420 29.0	26 1.8	12 0.8	1 0.1	31 2.1	[illegible] 0.2	7 0.5	2 0.1	4 0.3	1449 100.0

(CONTINUED)

APPENDIX B

Cross Tabulation of INCHAN by OUTCHAN

FILE NONAME (CREATION DATE = 03/15/74)
SUBFILE NORMAL

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
INCHAN BY OUTCHAN
* PAGE 1 OF 4

INCHAN	COUNT / ROW PCT / COL PCT / TOT PCT	AUTCDIN 1	FMAA 2	FMCC 3	FMEE 4	FCMP 5	FSPC 6	CARLISLE 8	KITTY HAWK 9	CORAL SEA 10	CHICAGO 11	ROW TOTAL
AUTCDIN	1	2	122	155	79	15	19	3	124	85	7	1175
		0.2	10.4	13.2	6.7	1.3	1.6	0.3	10.6	7.2	0.6	80.7
		0.8	99.2	98.1	100.0	100.0	100.0	18.8	98.4	96.6	100.0	
		0.1	8.4	10.6	5.4	1.0	1.3	0.2	8.5	5.8	0.5	
SHIP SHORE	2	55	0	3	0	0	0	0	0	0	0	58
		94.8	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
		21.1	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		3.8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
HOLLISTER	3	10	0	0	0	0	0	0	0	0	0	10
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
		3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CORAL SEA	4	63	0	0	0	0	0	0	1	0	0	64
		98.4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	4.4
		24.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	
		4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	
CHICAGO	5	6	0	0	0	0	0	0	0	0	0	6
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
		2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
KITTY HAWK	6	20	0	0	0	0	0	0	0	0	0	20
		100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
		7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
		1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CARLISLE	7	44	0	0	0	0	0	13	0	0	0	57
		77.2	0.0	0.0	0.0	0.0	0.0	22.8	0.0	0.0	0.0	3.9
		16.9	0.0	0.0	0.0	0.0	0.0	81.3	0.0	0.0	0.0	
		3.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	
W. UNION	30	61	1	0	0	0	0	0	1	3	0	66
		92.4	1.5	0.0	0.0	0.0	0.0	0.0	1.5	4.5	0.0	4.5
		23.4	0.8	0.0	0.0	0.0	0.0	0.0	0.8	3.4	0.0	
		4.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.0	
COLUMN TOTAL		261	123	158	79	15	19	16	126	88	7	1456
		17.9	8.4	10.9	5.4	1.0	1.3	1.1	8.7	6.0	0.5	100.0

(CONTINUED)

CROSSTABS FOR NORMAL DAY 03/15/74 PAGE 6

FILE NONAME (CREATION DATE = 03/15/74)
SUBFILE NORMAL

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
INCHAN BY OUTCHAN
* PAGE 2 OF 4

INCHAN	COUNT / ROW PCT / COL PCT / TOT PCT	OUTCHAN: SKAGGS ISLAND 22	JIM CREEK 23	DIXON 24	ROW TOTAL
AUTODIN	1	549 46.7 100.0 37.7	2 0.2 100.0 0.1	13 1.1 100.0 0.9	1175 80.7
SHIP SHORE	2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	58 4.0
HOLLISTER	3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	10 0.7
CORAL SEA	4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	64 4.4
CHICAGO	5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	6 0.4
KITTY HAWK	6	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	20 1.4
CARLISLE	7	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	57 3.9
W. UNION	30	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	66 4.5
	COLUMN TOTAL	549 37.7	2 0.1	13 0.9	1456 100.0

CROSSTABS FOR EXERCISE DAY 03/15/74 PAGE 5

FILE NONAME (CREATION DATE = 03/15/74)
SUBFILE EXERCISE

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
INCHAN BY OUTCHAN
* PAGE 1 OF 6

OUTCHAN (COUNT / ROW PCT / COL PCT / TOT PCT)

INCHAN		Autodin 1	EMAA 2	FMCC 3	FMEE 4	FCMP 5	FSPG 6	XRTT 7	CORAL SEA 10	CHICAGO 11	HORNE 12	ROW TOTAL
AUTODIN	51	6 0.4 1.8 0.3	189 13.4 97.4 10.2	234 16.6 95.9 12.7	153 10.8 92.7 8.3	29 2.1 100.0 1.6	36 2.6 100.0 2.0	11 0.8 24.4 0.6	100 7.1 100.0 5.4	20 1.4 95.2 1.1	45 3.2 75.0 2.4	1411 76.5
SHIPSHORE	52	60 92.3 17.7 3.3	0 0.0 0.0 0.0	1 1.5 0.4 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 3.1 3.3 0.1	65 3.5
SKAGGS IS	53	81 100.0 23.9 4.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	81 4.4
CORAL SEA	54	7 100.0 2.1 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 0.4
CHICAGO	55	10 83.3 2.9 0.5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 16.7 3.3 0.1	12 0.7
HORNE	56	49 57.6 14.5 2.7	0 0.0 0.0 0.0	5 5.9 2.0 0.3	1 1.2 0.6 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	16 18.8 35.6 0.9	0 0.0 0.0 0.0	1 1.2 4.8 0.1	0 0.0 0.0 0.0	85 4.6
JUNEAU	57	48 69.6 14.2 2.6	2 2.9 1.0 0.1	0 0.0 0.0 0.0	4 5.8 2.4 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	8 11.6 17.8 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	3 4.3 5.0 0.2	69 3.7
	COLUMN TOTAL	339 18.4	194 10.5	244 13.2	165 8.9	29 1.6	36 2.0	45 2.4	100 5.4	21 1.1	60 3.3	1845 100.0

(CONTINUED)

FILE NONAME (CREATION DATE = 03/15/74)
SUBFILE EXERCISE

* C R O S S T A B U L A T I O N O F *
INCHAN BY OUTCHAN
* PAGE 2 OF 6

INCHAN	COUNT ROW PCT COL PCT TOT PCT	OUTCHAN JUNEAU 13	JOUETT 14	HALSEY 15	BAIN-BRIDGE 16	PAUL REVERE 17	MONTE-CELLO 18	GRIDLEY 19	TI"A" 20	TI"B" 21	SKAGGS 22	ROW TOTAL
AUTCDIN	51	69 4.9 95.8 3.7	17 1.2 81.0 0.9	11 0.8 61.1 0.6	10 0.7 90.9 0.5	14 1.0 100.0 0.8	5 0.4 100.0 0.3	15 1.1 100.0 0.8	14 1.0 100.0 0.8	12 0.9 100.0 0.7	265 18.8 98.1 14.4	1411 76.5
SHIPSHORE	52	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 3.1 11.1 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	65 3.5
SKAGGS IS	53	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	81 4.4
CORAL SEA	54	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	7 0.4
CHICAGO	55	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	12 0.7
HORNE	56	2 2.4 2.8 0.1	4 4.7 19.0 0.2	5 5.9 27.8 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.2 0.4 0.1	85 4.6
JANEAU	57	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 2.9 0.7 0.1	69 3.7
	COLUMN TOTAL	72 3.9	21 1.1	18 1.0	11 0.6	14 0.8	5 0.3	15 0.8	14 0.8	12 0.7	270 14.6	1845 100.0

(CONTINUED)

FILE NCNAME (CREATICN CATE = 03/15/74)
SUBFILE EXERCISE

* * * * * * * * * * * * * * * * * * C R C S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * *
INCHAN BY OUTCHAN
* PAGE 3 OF 6

INCHAN	COUNT / ROW PCT / COL PCT / TOT PCT	OUTCHAN: JIM CREEK 23	DIXON 24	W. U. 25	ROW TOTAL
AUTCCIN	51	3	15	138	1411
		0.2	1.1	9.8	76.5
		100.0	78.9	100.0	
		0.2	0.8	7.5	
SHIPSHCRE	52	0	0	0	65
		0.0	0.0	0.0	3.5
		0.0	0.0	0.0	
		0.0	0.0	0.0	
SKAGGS IS	53	0	0	0	81
		0.0	0.0	0.0	4.4
		0.0	0.0	0.0	
		0.0	0.0	0.0	
CORAL SEA	54	0	0	0	7
		0.0	0.0	0.0	0.4
		0.0	0.0	0.0	
		0.0	0.0	0.0	
CHICAGC	55	0	0	0	12
		0.0	0.0	0.0	0.7
		0.0	0.0	0.0	
		0.0	0.0	0.0	
HORNE	56	0	1	0	85
		0.0	1.2	0.0	4.6
		0.0	5.3	0.0	
		0.0	0.1	0.0	
JANEAU	57	0	2	0	69
		0.0	2.9	0.0	3.7
		0.0	10.5	0.0	
		0.0	0.1	0.0	
	COLUMN TOTAL	3	19	138	1845
		0.2	1.0	7.5	100.0

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FILE NONAME (CREATION DATE = 03/15/74)
SUBFILE EXERCISE

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F *
INCHAN BY OUTCHAN
* PAGE 4 OF 6

INCHAN	COUNT ROW PCT COL PCT TOT PCT	OUTCHAN AutodIN 1	FMAA 2	FMCC 3	FMEE 4	FCMP 5	FSPG 6	XRTT 7	CORAL SEA 10	CHICAGO 11	HORNE 12	ROW TOTAL
JOUETT	58	33 63.5 9.7 1.8	3 5.8 1.5 0.2	0 0.0 0.0 0.0	5 9.6 3.0 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 7.7 8.9 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	5 9.6 8.3 0.3	52 2.8
HALSEY	59	16 84.2 4.7 0.9	0 0.0 0.0 0.0	1 5.3 0.4 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	2 10.5 3.3 0.1	19 1.0
BAINBRIDGE	60	8 36.4 2.4 0.4	0 0.0 0.0 0.0	3 13.6 1.2 0.2	2 9.1 1.2 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	6 27.3 13.3 0.3	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 4.5 1.7 0.1	22 1.2
PAUL REVERE	61	9 100.0 2.7 0.5	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	9 0.5
MONTECELLO	62	8 100.0 2.4 0.4	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	8 0.4
GRIDLEY	63	4 100.0 1.2 0.2	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 0.2
TI 'A'	64	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.1
	COLUMN TOTAL	339 18.4	194 10.5	244 13.2	165 8.9	29 1.6	36 2.0	45 2.4	100 5.4	21 1.1	60 3.3	1845 100.0

(CONTINUED)

FILE NONAME (CREATION DATE = 03/15/74)
SUBFILE EXERCISE

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
INCHAN BY OUTCHAN
* PAGE 5 OF 6

INCHAN	OUTCHAN COUNT ROW PCT COL PCT TOT PCT	JUNEAU 13	JOUETT 14	HALSEY 15	BAIN-BRIDGE 16	PAUL REVERE 17	MONTE-CELLO 18	GRIDLEY 19	TI 'A' 20	TI 'B' 21	SKAGGS 22	ROW TOTAL
JOUETT	58	1 1.9 1.4 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 1.9 9.1 0.1	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	52 2.8
HALSEY	59	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	19 1.0
BAINBRIDGE	60	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 4.5 0.4 0.1	22 1.2
PAUL REVERE	61	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	9 0.5
MONTECELLO	62	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	8 0.4
GRIDLEY	63	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 0.2
TI 'A'	64	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 100.0 0.4 0.1	1 0.1
	COLUMN TOTAL	72 3.9	21 1.1	18 1.0	11 0.6	14 0.8	5 0.3	15 0.8	14 0.8	12 0.7	270 14.6	1845 100.0

(CONTINUED)

FILE NCNAME (CREATICN CATE = 03/15/74)
SUBFILE EXERCISE

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I C N C F * * * * * * * * * * * * * * * * *
INCHAN BY OUTCHAN
* PAGE 6 CF 6

INCHAN	COUNT / ROW PCT / COL PCT / TOT PCT	OUTCHAN JIM CREEK 23	DIXON 24	W. U. 25	ROW TOTAL
JCUETT	58	0 0.0 0.0 C.0	0 0.0 0.0 0.0	0 0.C 0.0 0.0	52 2.8
HALSEY	59	0 0.0 0.0 C.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	19 1.0
BAINBRIDGE	60	0 C.0 C.C C.0	1 4.5 5.3 0.1	0 0.0 0.0 0.0	22 1.2
PAUL REVERE	61	0 0.0 C.0 C.0	0 0.0 0.0 C.0	0 0.0 0.0 0.0	9 0.5
MCNTECELLC	62	0 C.C C.0 C.0	0 C.0 0.0 0.0	0 0.0 0.0 0.0	8 0.4
CRIDLEY	63	0 0.0 C.0 C.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	4 0.2
TI 'A'	64	0 C.0 C.0 C.0	0 0.0 0.0 0.0	0 0.0 0.0 0.0	1 0.1
	COLUMN TOTAL	3 C.2	19 1.0	138 7.5	1845 100.0

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